Computer graphics—a new tool

Computer emulation is an advanced form of computer modeling. With it, you can put an entire handling system on a screen and watch it operate in real-time, *before* it's built. The benefits: greatly reduced field checkout and debugging time.

Emulation is a new tool that can help you overcome two of the biggest challenges in implementing large-scale automation: evaluating the operation of competing material handling system configurations and effectively testing these systems before construction.

Emulation is related to, yet different from another computer analysis technique, simulation. Simulation is often used to compare one alternative system design with another. The output—the information you receive—is usually numerical.

Computer emulation, on the other hand, is a graphic presentation on a video screen. The screen shows loads moving on a scale model of the entire handling system, complete with storage aisles, transfer devices, spurs, and so on. It can show the entire system at one time or any portion of the system.

You can actually see where bottlenecks occur, where incorrect diverges exist, and where the system is overloaded, if at all. Emulation can show if six guided vehicles, for example, will handle the throughput or if you should purchase a seventh vehicle.

You can also slow down or speed up the emulation. By running in "fast" time, you can log in days of system operating time in a few hours or so.

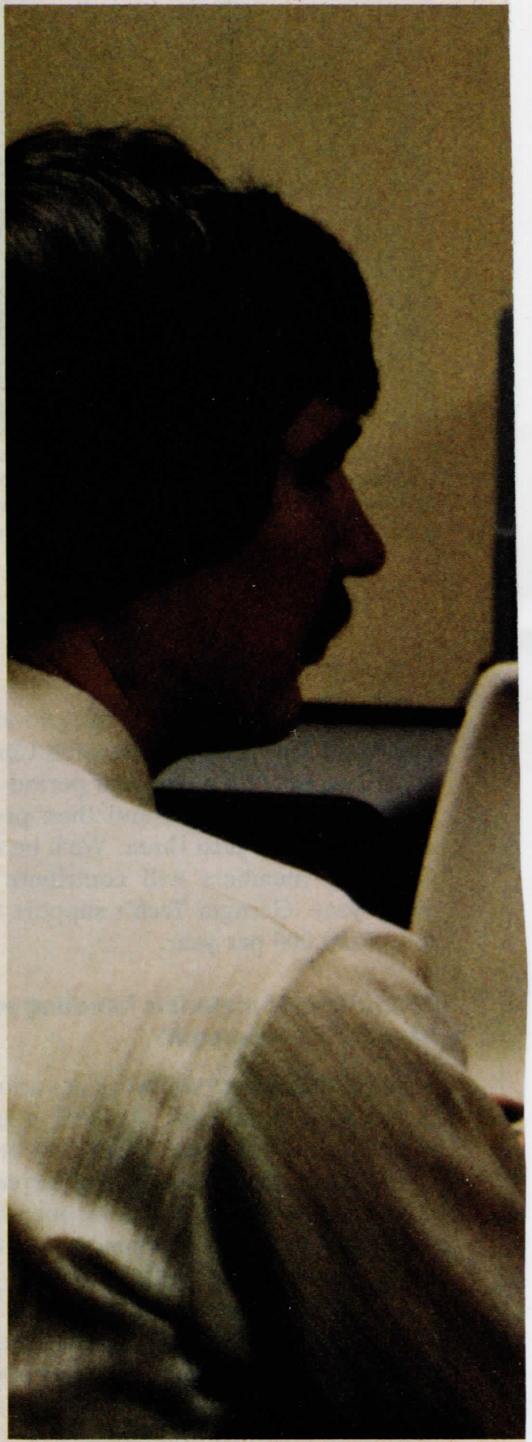
With computer emulation, you can achieve all of the following.

- Eliminate the limitations in time, space, and costs for a full-scale test.
- Reduce the time and costs for field installation, checkout, and startup.
- Provide a tool for analyzing existing operations and for recommending modifications without interrupting service.
- Verify in-house that the control system operates correctly.
- Ensure that the system meets the designed throughput rates.
- Predict system response.

Emulation versus simulation

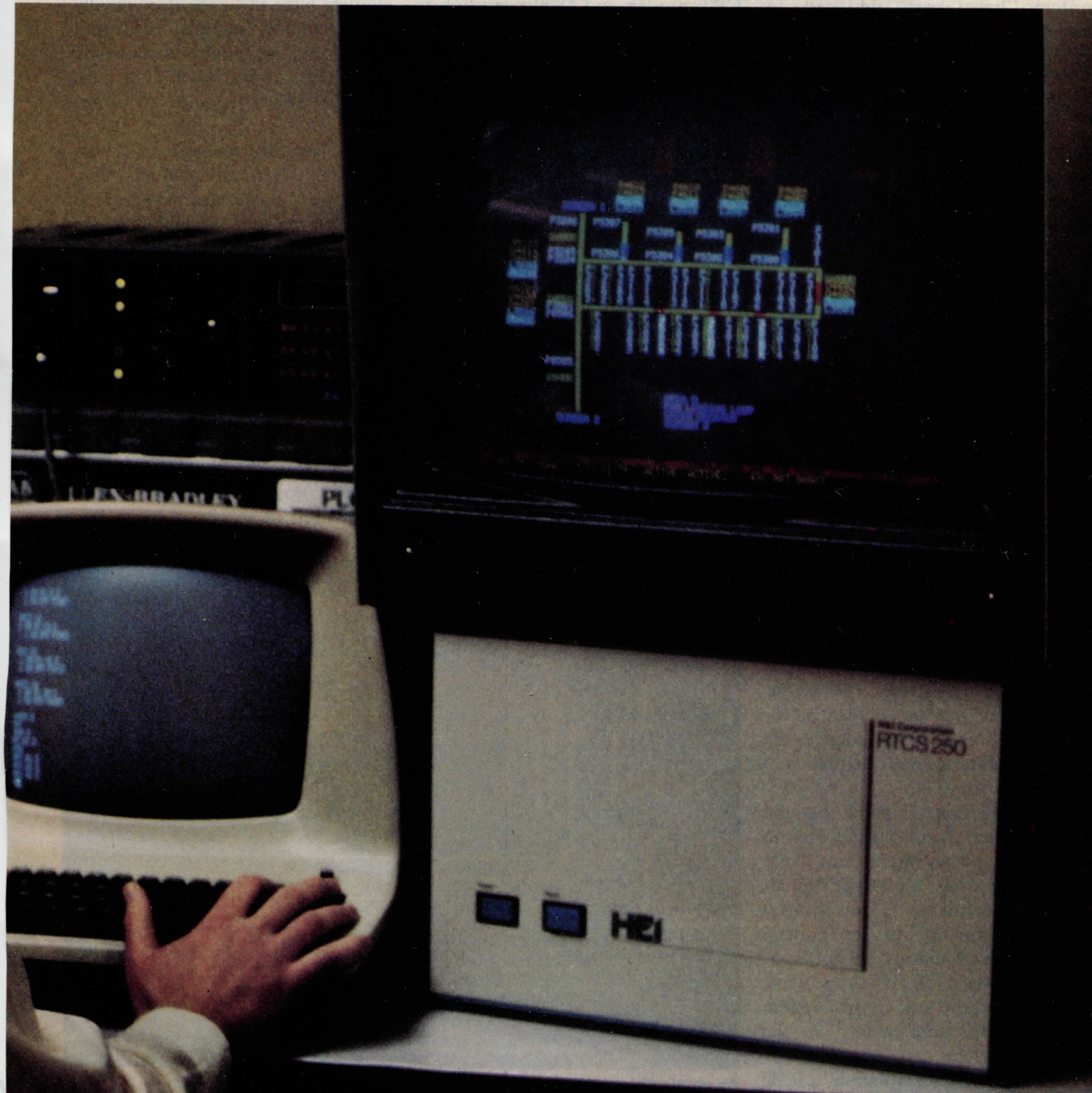
Computer emulation is a step "beyond" simulation. Like simulation, it simplifies the process of designing materials handling systems. However, the computer operates the "actual" system by using the real inputs and outputs from the minicomputers, programmable controllers (PC), or other control devices on the handling system.

The difference between simulation and emulation lies in the kinds of detail depicted; otherwise, the two are complementary modeling techniques. Simulation is ideal for evaluating preliminary system de-



A typical emulation system includes an operator's console, microcomputer, display, and the mechanical controller, Here, the operator watches simulated loads move across a network of conveyors and past photoelectric sensors.

for verifying system design



"You don't have to be a wizard in emulation to understand what's going on. Whatever errors occur, you see on the screen."

signs and for comparing design alternatives. It provides numerical information that is often unavailable from an emulation study. Emulation is used after the handling and control systems have been designed to evaluate the specific hardware.

Electronics mimics equipment

An emulation system, or emulator, consists of computers, a display terminal, and interfaces. A main computer stores data about the automated system, such as scheduling rules, material flows, conveyor lengths, and the location and types of sensors.

A microcomputer processes the data and acts as the handling system. An interface connects the microcomputer directly to the I/Os on the control devices used on the automated system. The CRT and keyboard provide the communications between the emulator and the user.

The emulator receives commands and operating status changes from the control devices. These output signals are processed by the emulator just as if the actual handling system were in operation.

The emulator then responds with control device input signals to reflect changes in real-time operation. These inputs can be to turn motor starters on and off or change the operating status of limit switches and photo detectors.

However, keep in mind that the motor starters, limit switches, photo detectors, and so on, do not exist. They are merely electronic signals from the emulator to the control devices. Similarly, to the control devices, the emulator does not exist. They operate as if they were connected to the real control system and the real equipment on the handling system.

Throughout the emulation, a scale model of the handling system in operation is being shown on a CRT.

One emulation system (HEI Corporation) sells for $38,500. The system can be rented on a consulting basis at $400 per day to produce the CRT display and $800 per week to run an emulation sequence.

Operation is easy to learn. No computer programming knowledge is required. Training takes about a week; you can become fully proficient in one month.

Checkout time slashed

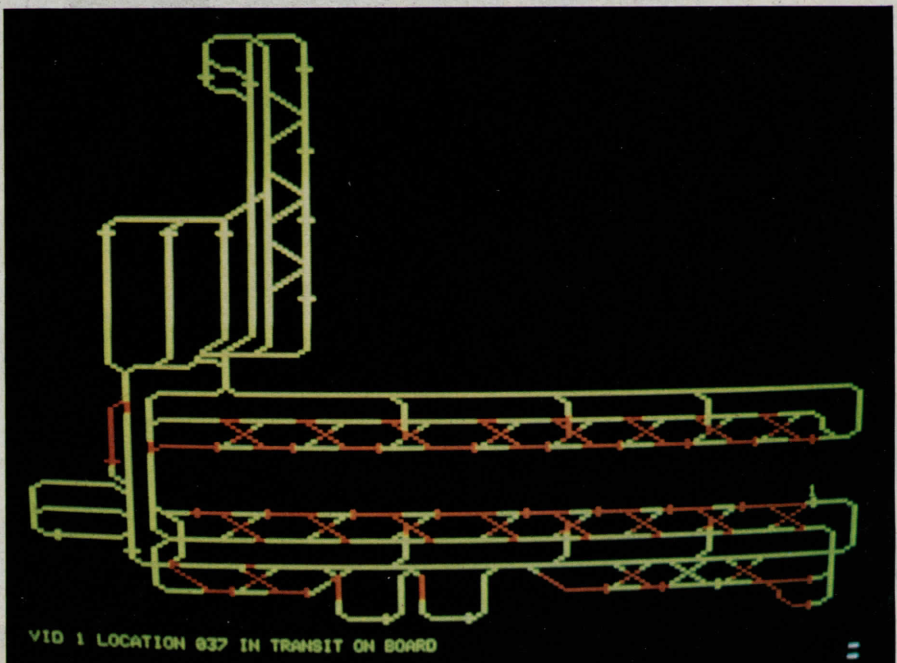
Emulators are being used by several equipment suppliers for designing and analyzing a variety of materials handling systems. Of course, the more complex the system, the greater the payoff in savings provided by the emulation.

Conco-Tellus is one of the companies using an emulation system. For over a year, the system has helped them design conveyor, stacker crane, and warehouse management systems.

"The emulator eliminates wiring toggle switches to the real I/O. Granted, you can emulate the control logic by turning the switches on and off manually, but you can't emulate large throughputs manually. The emulator, though, easily imitates this throughput with its multi-input levels," says Don Fiste, chief electrical engineer at Conco-Tellus.

Van Norman, manager of simulations at Auto Simulations, Inc., estimates hardware savings of $250,000 on one handling project with which he was involved. "Emulation is the cheapest insurance you can buy. Its real value comes in defining the control algorithms at the early design stages and in knowing that the system will work.

"You test both the mechanical adequacy of the components and the control software that is going to utilize those components. And, when used in the later stages of a



An automatic guided vehicle system, with 10,000 ft of guidepath (green) and 19 vehicles (red) is displayed on a screen.

project, emulation offers tremendous savings in time and money."

A supplier of AS/R systems used emulation on a complex project that contained three PCs, each of which contained the equivalent of over 2,000 relays. Two PCs controlled a unit load conveyor and one operated a mini-load AS/R machine. The project also included eight AS/R machines, 4,000 ft of conveyor, hundreds of motors and photocells, and about a dozen vertical lifts.

The supplier estimates that the emulator chopped field checkout time 50%, which reduced the supplier's staffing costs and reduced the need for field electricians during installation and checkout. This savings represents about 10% of the control budget.

Another supplier built a four-aisle AS/RS that contained about 160 I/Os and 25 motor drives. With the emulator, field bugs were reduced by an estimated 75% and debug time was slashed 83%—from an expected six weeks to one.

The design of a light capacity monorail system was cut from six months to six weeks by a third supplier. The project contained over 400 carriers traversing multipath routes.

And what does this mean to you? According to Tom Crandall at Acco Babcock Industries, "Emulation helps guarantee system operation. It puts pressure on the materials handling vendor to both guarantee the throughput as defined by the customer and to duplicate the throughput as shown by the emulation system."

Also, you might want to buy an emulation system for yourself to give you a tool to independently evaluate a supplier's system design, especially when your materials handling system is at the forefront of the state-of-the-art in automated systems.

How you "build" a handling system on a CRT

I/O DEFINITION TABLE CUSTOMER: SAMPLE PAGE: 1 OF 1

TABLE TYPE	SCREEN #	SIGNAL NAME	DISPLAY COLOR	HORIZ -VERT	LOCATION ROW	COL	I/O ADDRESS
DEF	1	M1	GRN	HORIZ	3	6	00100
DEF	1	M2	GRN	HORIZ	3	13	00101
DEF	1	M3	GRN	VERT	6	17	00102
DEF	1	M4	GRN	HORIZ	8	25	00103
DEF	1	MU1	YEL	HORIZ	5	20	00104
DEF	1	MD1	YEL	HORIZ	6	20	00105
DEF	ENDPCO	1					

The layout of the handling system is "constructed" by entering data into prearranged tables. Here, the entries in the I/O Definition Table list the sensor names and the corresponding PC I/O bit addresses with the page number, color, and location of the sensor on the final CRT display.

To "build" and "run" a handling system on a CRT, you start with a detailed layout of the system. It should include the location of conveyors or monorails, AGVS guidepaths, or AS/RS lanes. Sensors should be indicated in their proper location. Likewise, other equipment, such as motors, trolleys, and transfer devices, should be indicated. And the logic of how everything operates and interacts should be formalized.

This information is entered into the emulator, which can be a time-consuming job. With some emulators, the handling system with its I/O devices must be sketched on graph paper. Each square on the graph represents a "pixel" or picture element, in this case, the dot on a CRT screen.

The layout on the graph paper is entered into the emulator, pixel by pixel. A user can type this in by the row and column for each pixel. Or, the user can point to each pixel on a special electronic workpad or on the screen itself with a joystick, light pen, or touch activated screen. The computer then determines the exact location of the pixel.

Construction continues by entering the rest of the information in the special tabular formats required by the emulator. For example, to label the display with legends and annotations on one emulator, the user types in the color orientation (horizontal or vertical), and location of the label plus the label itself.

By using similar tabular formats, the user enters in the location and type of equipment on the handling system, such as photoelectric sensors and programmable controllers. Another table is used to input the operating parameters of the system, such as the transfer times for transfer devices and vertical lifts. A third table—there are ten altogether—is used to specify the control logic, such as what action is required at divergence points.

A typical handling operation scenario is then set up. This is done by identifying the quantity and time materials enter the handling system. The handling system is now "built" and ready to run.